

We Don't Cotton to Boll Weevil 'Round Here Anymore

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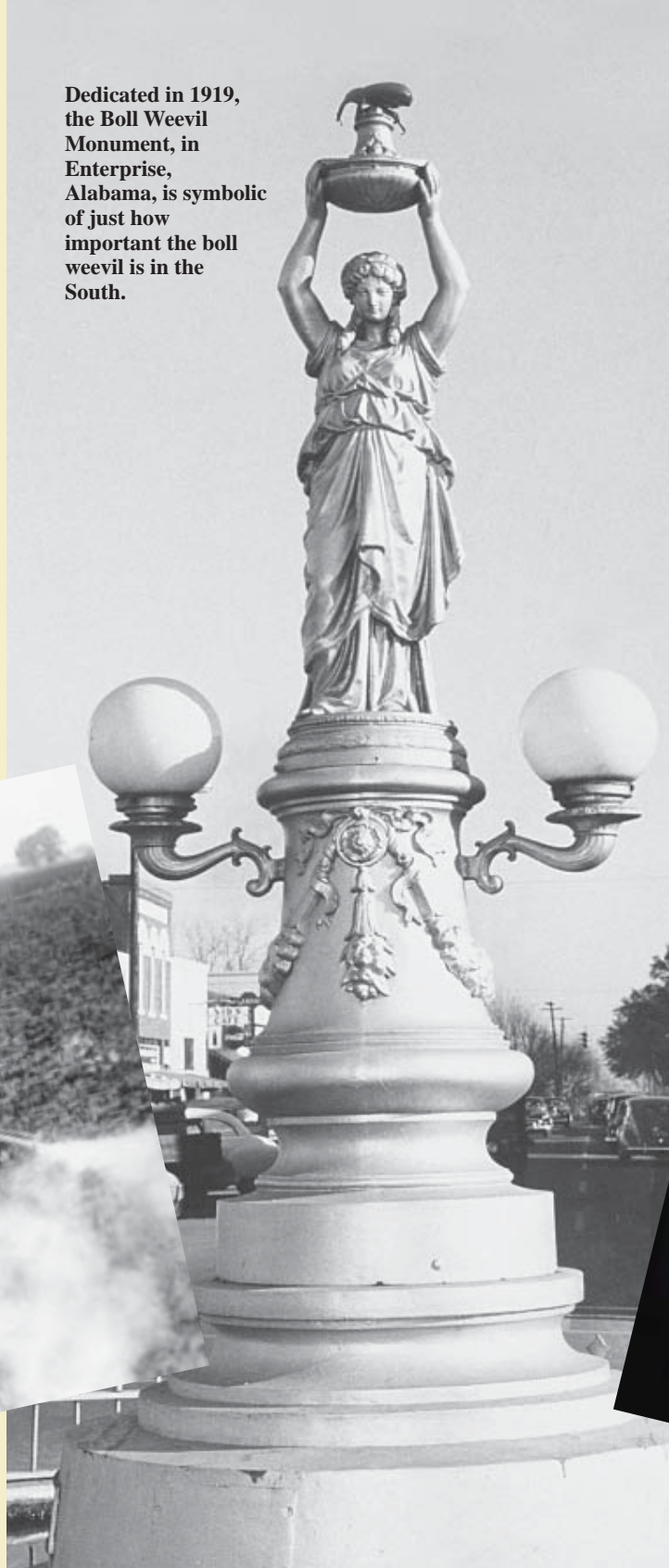
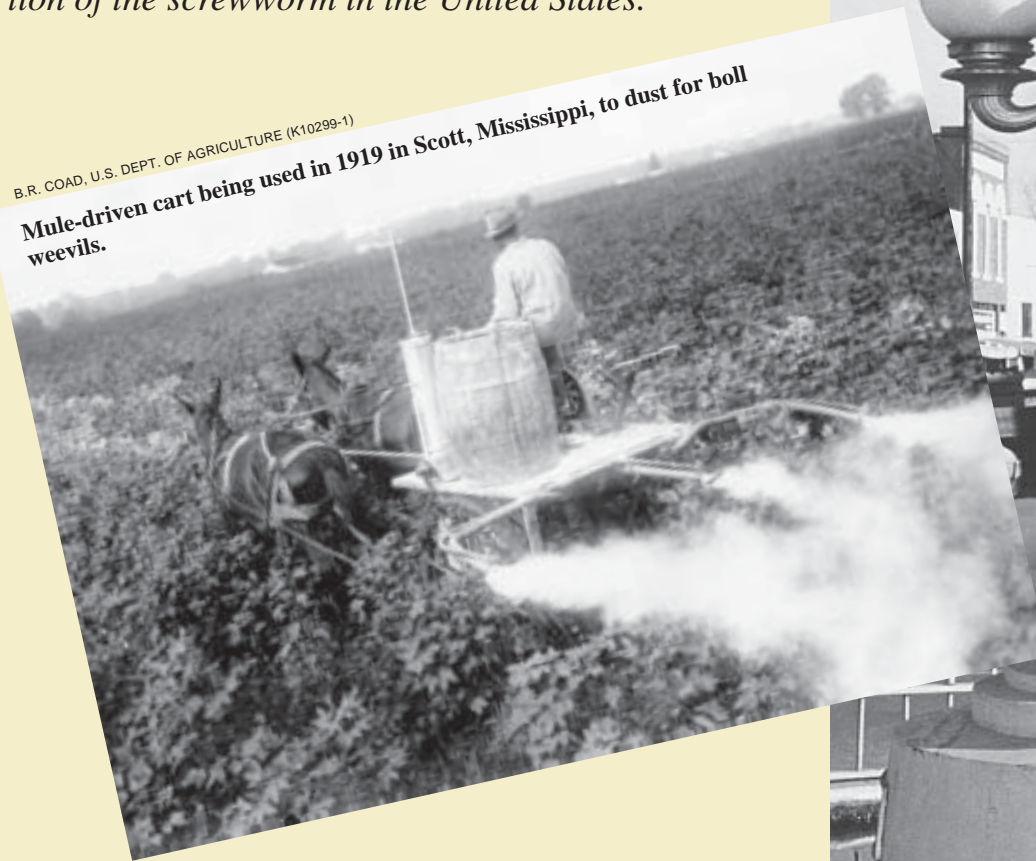
*The farmer said to the merchant
I need some meat and meal.
Get away from here, you son-of-a-gun,
You got boll weevils in your field.
Going to get your home, going to get your home.*
—Carl Sandberg's version of "The Boll Weevil Song," 1920

Agricultural Research Service boll weevil scientists have almost succeeded in working themselves out of a mission in the best possible way—by having helped to create a program that is closing in on its goal of eradicating the boll weevil from the United States.

Boll weevil eradication has been a monumental success story, often compared in scope to the elimination of the screwworm in the United States.

Dedicated in 1919, the Boll Weevil Monument, in Enterprise, Alabama, is symbolic of just how important the boll weevil is in the South.

B.R. COAD, U.S. DEPT. OF AGRICULTURE (K10299-1)
Mule-driven cart being used in 1919 in Scott, Mississippi, to dust for boll weevils.



For more than 100 years, boll weevils wreaked havoc on the U.S. cotton industry. Since its entry into the United States from Mexico in 1892, the insect scientifically known as *Anthonomus grandis* Boheman spread throughout the South, forcing radical economic and social changes in areas that had been almost completely dependent on cotton production. Many experts consider the boll weevil second only to the Civil War as an agent of change in the South. Over the years, estimates of yield losses and control costs due to the boll weevil total more than \$22 billion.

Hope for stopping the boll weevil in its beetle tracks was relatively bleak until the 1970s, when research by ARS and universities like Texas A&M, Louisiana State University, Mississippi State University, and others evolved into a complex of tools that had the potential to remove

this foreign invader from the country.

Today, the boll weevil is in full retreat throughout the South. Since the program was first pilot tested in 1978 along the Virginia-North Carolina border, the pest has been eradicated from more than 6 million acres. There are active eradication programs in various stages of completion on over 9 million acres in 17 U.S. states and in parts of northern Mexico. Where the boll weevil has already been eliminated, cotton has made a significant return, especially in traditional growing areas like the Carolinas, which were declared essentially boll weevil free in 1986.

“There haven’t been many pest programs that have been as successful as this one. And without this program, there would be very little, if any, cotton grown in the Southeast today,” explains Jim Brumley, executive director of the Southeastern Boll Weevil Eradication Foundation. “The real key to our success is that we have had good research to apply. We couldn’t have developed or carried out this program without the

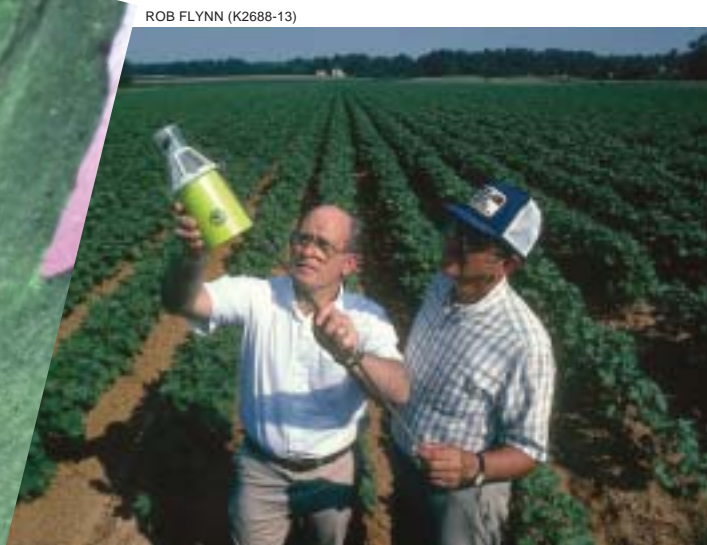
research that was done by ARS and others.”

Cotton grower foundations like the one Brumley heads are the organizational backbone of the boll weevil eradication program, which is funded about 70 percent by cotton growers and 30 percent through USDA’s Animal and Plant Health Inspection Service (APHIS). As the program moves toward completion, ARS continues to provide critical research to support field operations.

Bill Grefenstette, APHIS’ national coordinator for boll weevil eradication, sees the cooperation among all those involved in the program as key to making boll weevil eradication a reachable goal. “I’m not sure many people realize how big an undertaking this program really is—taking on one of the most important insect pests in our history and involving 17 states and more than 15 million acres,” Grefenstette says. “The overall program, including ARS’ linchpin research—along with the Cooperative State Research, Education, and Extension Service, the universities, Extension Service, the states, the industry, the



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ROB FLYNN (K2688-13)

Left: Boll weevil on a cotton boll.
Above: ARS entomologist Bill Dickerson (left) and cotton farmer Marshall Grant examine a boll weevil pheromone trap on Grant’s farm in North Carolina. These traps have been key to the success of the eradication program. (Photo taken in 1987.)

growers, and thousands of dedicated employees—has been a model of how folks can cooperate in setting a critically important goal and then working together to accomplish it.”

Seeds of Success

The seeds of today’s successful eradication program were planted in the late 1950s, when two factors coincided. The U.S. cotton industry, facing serious economic challenges, focused on elimination of the boll weevil as one of the best ways to reduce its enormous costs.

At the same time, a major revolution was under way in entomology and insect pest control, started by ARS entomologist Edward F. Knipling. He had devised an areawide pest-management program that was already showing tremendous success eradicating screwworm from the United States.

Knipling’s success was convincing evidence that it was feasible to eliminate a pest by striking at it through its biology. Even the format for the boll weevil program took its direction from the screwworm program. The Southwest Animal Health Foundation, which was formed to facilitate screwworm eradication in the Southwest, later served as a template for the boll weevil eradication foundations.

Joining the commitment to do away with the boll weevil, ARS built the Boll Weevil Research Laboratory (BWRL) in Starkville, Mississippi, in 1961. In addition, boll weevil research was significantly strengthened at other ARS labs.

These researchers came up with two linchpins of today’s successful eradication program: an effective, inexpensive detection trap and a pheromone lure.

To identify the pheromone, first a way to test candidate compounds on live boll weevils—a bioassay—needed to be developed. That work was done between 1965 and 1969 by Dick Hardee, now research leader of ARS’ Southern Insect Management Research Unit in Stoneville, Mississippi.

“Three years after I came up with a good bioassay, Jim Tumlinson called me up and asked if I had a good crop of boll weevils ready for an assay because he was pretty sure he had come up with the pure pheromone,” Hardee says. Now research leader of the ARS Chemistry Research Unit in Gainesville, Florida, Tumlinson was then a graduate student working for ARS at the Mississippi State University facility.

What Tumlinson found were four compounds that, in combination, were as attractive to female boll weevils as live males were. None of the compounds was active alone, which had made isolation and purification more difficult.

Isolating a pheromone in 1969 was still new research territory, and the equipment was not very sensitive. Tumlinson had to isolate about 10 milligrams of each compound to characterize it; today, compounds are routinely identified from 1 microgram and sometimes even from 1 nanogram, a 10,000- to 10-millionfold reduction in sample requirements.

Tumlinson recounts, “To get enough of each compound to determine the structure, I eventually extracted and steam-distilled 54 kg of boll weevil feces.”

Hardee christened the pheromone complex Grandlure, which continues to be one of the four or five most effective pheromone lures in commercial use.

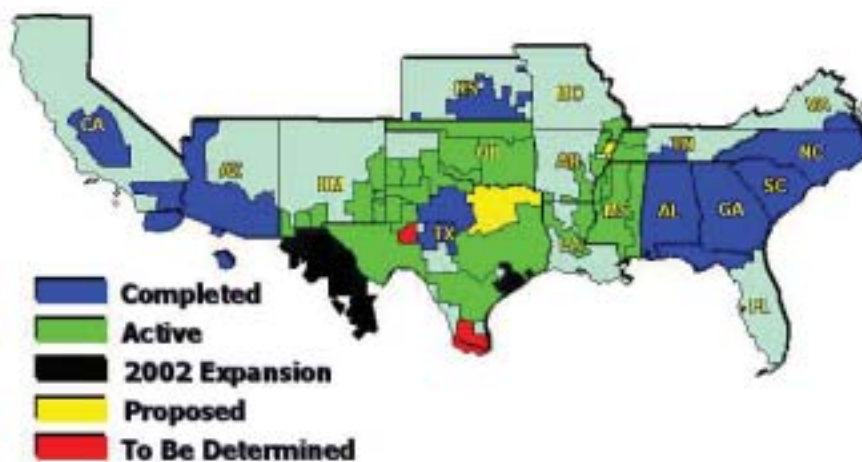
During the same period, Joseph E. Leggett, who was then with the BWRL, made a quantum leap forward in trap design, creating an effective live trap from an inverted floral paperliner. Several more generations of refinements were made by a number of ARS researchers until they came up with the design still being used today. More than 20 million of these traps have been used in the United States since 1987.

“Growers had just been waiting for us to come up with these two tools to dig into planning an eradication program,” Hardee explains. With a trap and a lure, insecticide use could be targeted to boll weevil appearance in cotton fields.

Using Biology Against the Boll Weevil

The boll weevil eradication program depends primarily on detection and carefully targeted insecticide use, unlike the screwworm program to which it is often compared but which depended on biological control—releasing sterile male insects to prevent reproduction. But it

BOLL WEEVIL ERADICATION IN THE UNITED STATES AND MEXICO



was Knipling's advocacy in both programs for research to understand the two pests' biology and ecology that laid the groundwork for so much of the boll weevil eradication program's success.

Researchers had to learn and are still learning about such traits as how far boll weevils will travel, especially in the face of strong winds; what other plants attract them; and the insects' diapause, or winter dormancy.

An ARS team led by Edwin P. Lloyd at BWRL focused on finding a way to use diapause as an effective time to reduce the boll weevil population while reproduction slows. In 1968, the team conducted a 5,000-acre "reproduction-diapause" control technique demonstration in Mississippi. It successfully used for the first time a system of targeting insecticide applications to diapausing boll weevils and monitoring pheromone traps.

ARS researchers then gathered all the available research—theirs and that of many other scientists—and built a model of an areawide eradication system that would eliminate boll weevils. The next step was to find a large cotton-growing area, convince the growers to participate, and start eradicating boll weevils.

A pilot test of control techniques was run in southern Mississippi and adjacent cotton growing areas in Alabama and Louisiana from 1971 to 1973. For the first time, it was shown that boll weevil eradication was finally technologically feasible.

Then, with the support of the National Cotton Council and the approval of the majority of local growers, a 3-year Boll Weevil Eradication Trial began in Virginia and northern North Carolina in 1978, conducted by APHIS with research support from ARS.

The trial proved to be an overwhelming success and established the operational strategy for all future

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Cotton farmer Marshall Grant and his wife in 1987.

FEAR NO WEEVIL

Marshall Grant and his family have been growing cotton in North Carolina since the 1780s. But boll weevils almost put him out of business between the environmental and economic costs of control.

"We were spraying insecticides every 5 days until the bolls were mature. Now that boll weevils have been eradicated from the Carolinas we're down to an average of one, maybe one and a half sprayings per year for other pests," Grant says. "The eradication program has made the difference between there being cotton production here and there not being any cotton production in North Carolina."

programs as they spread throughout the South.

"The model that ARS developed has been the key to success in each new state as growers voted to go for eradication," says Charles T. Allen, program director of the Texas Boll Weevil Eradication Foundation. "There has always been so much politics and contention in cotton production. If the plan hadn't come from ARS and other collaborators, I'm not sure that growers would have had as much confidence in the possibility of eradication."

Allen worked for the Texas Agricultural Extension Service with cotton growers for 20 years before joining the Texas foundation. Until he saw the eradication program in use, he could hardly believe that he would ever see the day when the boll weevil would be eliminated. "Now I think I will see it to completion before the end of my career," Allen says.

Costs and Payoffs

At one time, cotton growers applied more than 41 percent of all insecticides in agricultural use; they regularly sprayed their cotton as many as 15 times a season. In the first season of an eradication program, an average of seven or eight insecticide applications are timed for the fall, just before diapause. In subsequent years, insecticide application is based on finding boll weevils in traps, with an average of five applications in the second year and only two in the third year.

"Eradication is expensive to begin with, but the payoff is tremendous as the program moves along," explains Frank Carter of the National Cotton Council of America. "Early on, our studies showed about a 12:1 benefit-to-cost return to the cotton industry for every dollar invested in eradication."

But the economic payoff is really just starting, he points out. Pesticide costs

continue to decrease as eradication succeeds in more and more states. There will be generations of cotton growers who may never have to spray for boll weevils. "Every year that happens will be a payoff of this program," Carter adds.

One ARS contribution in the mid-1990s that helped the economic viability of the program was finding that lower doses of malathion, the only insecticide currently used for eradication, are just as effective as higher ones. This decreased the cost of the program dramatically.

In addition to significantly lower control costs, there are environmental benefits of trading weekly spraying by individual growers for nationwide eradication. By reducing the amount of pesticides being used as the eradication program succeeds, more beneficial insects survive to protect cotton from other pests. As the ecosystem changes, researchers have had to conduct additional studies to ensure that no new problems are created for growers in place of the boll weevil.

There have even been some unexpected payoffs of ARS boll weevil research. In January 2002, after checking out new ARS research on the boll weevil's inability to survive in or on compacted cotton bales, APHIS and Peruvian agricultural officials reached an agreement to remove the mandatory fumigation of U.S. cotton bales with methyl bromide to prevent spread of boll weevil. Curtailing fumigation will significantly reduce the cost of exporting cotton to Peru. A similar agreement has been reached with Colombia, and discussions are being held with Pakistan and other countries.

Finishing the Job

Although the eradication foundations are closing in on final success, there remain several major issues on which ARS continues to conduct research, says entomologist Dale W. Spurgeon with the ARS Areawide Pest Management Research Unit, College Station, Texas.

Spurgeon is also ARS' lead scientist for the agency's boll weevil efforts.

One issue is the impact of conservation tillage, also called no-till, on the eradication program. "We have some indications that boll weevil survival is different in no-till," Spurgeon says. "We need to understand and adapt to the effects of no-till as it becomes a more common practice in eradication zones."

Another issue left for research is completing a DNA fingerprint library of boll weevils so that when one reappears in an eradicated area, its source can be identified. This will also help identify the most effective locations for detection traps.

And the effect of weather, especially of extreme events like hurricanes, on the

What a Difference No Boll Weevil Makes

The year before boll weevils marched into Georgia in 1915, the state produced 2.8 million bales of cotton. Less than 10 years later, Georgia's annual cotton production had fallen to 600,000 bales. By 1983, Georgia cotton production was down to 112,000 bales harvested from 115,000 acres.

But in 1987, Georgia began a boll weevil eradication program. A decade later, in 2000, cotton production in Georgia had rebounded to 1.66 million bales. In this one state alone, the cotton industry, including farms, gins, warehouses, cottonseed oil mills, and textile mills, provides 53,000 jobs and has an overall economic impact of more than \$3 billion each year.

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The presence of beneficial insects such as the lady bird beetles on this cotton bloom are testimony to the benefit of reduced pesticide use as a result of the boll weevil eradication program.

potential for the boll weevil to reenter the United States from Mexico also needs study.

"Understanding how and why control measures work is essential to the continued progress of eradication," Spurgeon says. "If we don't know why something happens, how can we be ready to correctly tweak the eradication model to deal with it?"

But Spurgeon and the other ARS boll weevil researchers have created a Catch-22 for themselves. The program has just about eradicated them out of places to do their research. Once the boll weevil has been eliminated from a state, they can't do research there anymore. That's because they they don't want to inadvertently reintroduce the insect.

"I can't say I'm too upset at the prospect, since complete eradication has been our goal for so long," he says.—

By J. Kim Kaplan, ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at <http://www.nps.ars.usda.gov>.

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